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# Standard Specification for Powder Metallurgy (P/M) Boron Stainless Steel Structural Components<sup>1</sup>

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<sup>1</sup> This specification is under the jurisdiction of ASTM Committee B-9 B09 on Metal Powders and Metal Powder Products and is the direct responsibility of Subcommittee B09.11 on Near Full Density Powder Metallurgy Materials.

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## 1. Scope

1.1 This specification covers stainless steel powder metallurgy (P/M) structural components with a 7.7-g/cm<sup>3</sup> minimum density, which density that are fabricated from prealloyed powder consisting primarily of iron, chromium, nickel, molybdenum, and boron<sup>2</sup> and are intended for use in corrosive service.

1.2 The values stated in inch-pound units are to be regarded as the standard. The SI values given in parentheses are for information only.

## 2. Referenced Documents

### 2.1 ASTM Standards:

A 262 Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels<sup>3</sup>

B 117 Practice for Operating Salt Spray (Fog) Apparatus<sup>4</sup>

B 243 Terminology of Powder Metallurgy<sup>5</sup>

B 311 Test Method for Density Determination for Powder Metallurgy (P/M) Materials Containing Less than Two Percent Porosity<sup>5</sup>

E 8 Test Methods for Tension Testing of Metallic Materials<sup>6</sup>

E 354 Test Methods for Chemical Analysis of High-Temperature, Electrical, Magnetic, and Other Similar Iron, Nickel, and Cobalt Alloys<sup>7</sup>

E 572 Test Method for X-Ray Emission Spectrometric Analysis of Stainless Steel<sup>7</sup>

E 1019 Test Methods for Determination of Carbon, Sulfur, Nitrogen, and Oxygen in Steel and in Iron, Nickel, and Cobalt Alloys<sup>7</sup>

E 1086 Test Method for Optical Emission Vacuum Spectrometric Analysis of Stainless Steel by the Point-to-Plane Excitation Technique<sup>7</sup>

G 48 Test Method for Pitting and Crevice Corrosion Resistance of Stainless Steels and Related Alloys by Use of Ferric Chloride Solution<sup>4</sup>

## 3. Terminology

3.1 *Definitions*—Definitions of powder metallurgy terms can be found in Terminology B 243. Additional descriptive information is in the Related Material section of Volume 02.05 of the *Annual Book of ASTM Standards*.

## 4. Ordering Information

4.1 Orders for components under this specification shall include the following information:

4.1.1 Dimensions (see Section 9),

4.1.2 Chemical composition (see Section 6 and Table 1),

4.1.3 Density (see Section 7),

<sup>2</sup> U.S. Patents 3980444, 4014680, 4032336.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 01.03.

<sup>4</sup> *Annual Book of ASTM Standards*, Vol 03.02.

<sup>5</sup> *Annual Book of ASTM Standards*, Vol 02.05.

<sup>6</sup> *Annual Book of ASTM Standards*, Vol 03.01.

<sup>7</sup> *Annual Book of ASTM Standards*, Vol 03.05.

**TABLE 1 Chemical Composition Requirements**

Element	Composition Limits, Weight %
Carbon	0.05 max
Manganese	2.00 max
Phosphorus	0.03 max
Sulfur	0.03 max
Silicon	1.00 max
Silicon	1.0 max
Chromium	22.00 to 24.00
Chromium	22.0 to 24.0
Nickel	17.00 to 19.00
Nickel	17.0 to 19.0
Molybdenum	3.00 to 4.00
Molybdenum	3.0 to 4.0
Boron	0.20 to 0.50
Nitrogen	0.10 max
Iron <sup>A</sup>	remainder
Iron <sup>A</sup>	balance

<sup>A</sup> Iron shall be determined arithmetically by difference.

4.1.4 Mechanical properties (see Section 8 and Table 2),

4.1.5 Certification (see Section 13),

4.1.6 Reference to the standard.

## 5. Materials and Manufacture

5.1 Structural components shall be made by cold pressing and sintering prealloyed powder.

5.2 The sintering temperature is dependent on the chemical composition of the powder.

## 6. Chemical Composition

6.1 The material shall conform to the composition limits specified in Table 1.

6.2 Chemical analysis should be made in accordance with Test Methods E 354, E 572, E 1019, and E 1086.

## 7. Physical Properties

7.1 *Density*:

7.1.1 The sintered density shall be 7.7-g/cm<sup>3</sup> minimum.

7.1.2 Density shall be determined in accordance with Test Method B 311.

## 8. Mechanical Properties

8.1 The purchaser and manufacturer shall agree upon the method to be used to verify the typical yield or tensile strength in the finished parts. The preferred method for verifying the tensile or yield strength is for the manufacturer and purchaser to agree upon a qualification test to be performed on the actual part. The specific test should be determined after consideration of the function of the part. An example would be measuring the force needed to break teeth off a gear, using a prescribed fixture.

8.2 The tensile properties of the material may also be verified using specifically prepared bars, compacted from the same mixed powder lot as the purchased parts, and sintered along with the parts.

8.3 Typical tensile values for 0.2 % offset yield strength, ultimate strength, and percent elongation in 1-in. gage length for as-sintered standard flat unmachined tension test specimens for powder metallurgy (P/M) products (see Fig. 19 of Test Methods E 8) are in Table 2.

## 9. Dimensions and Tolerances

9.1 Dimensions and tolerances of the structural components shall be indicated on drawings accompanying the purchase order or contract.

## 10. Sampling

10.1 *Lot*—Unless otherwise specified, a lot shall consist of components of the same form and dimensions made from the same

**TABLE 2 Typical Mechanical Properties<sup>A</sup>**

0.2 % Offset yield strength	35 000 psi (240 MPa)
0.2 % Offset yield strength	33 000 psi (228 MPa)
Ultimate tensile strength	76 000 psi (520 MPa)
Elongation in one inch	23 %
Hardness	84 HRB
Hardness	75 HRB

<sup>A</sup> Determined on a cold-pressed and vacuum-sintered standard flat unmachined test specimen for powder metallurgy (P/M) products (see Fig. 19 of Test Methods E 8).

mixed powder lot, compacted, and processed under the same conditions, and submitted for inspection at one time.

10.2 *Chemical Analysis*—If required by purchase agreement, at least one sample for chemical analysis shall be taken from each lot. A representative sample of chips may be obtained by dry-milling, drilling, or crushing at least two pieces without lubrication using clean dry tools.

10.3 *Mechanical Testing*—If required by the purchase agreement, the manufacturer and purchaser shall mutually agree on the representative number of specimens for mechanical testing from each lot. This number shall be based on good practice of statistical quality control.

## 11. Inspection

11.1 Unless otherwise specified, inspection of components supplied on contract shall be made by the purchaser.

## 12. Rejection and Rehearing

12.1 Components that fail to conform to the requirements of this specification may be rejected. Rejection shall be reported to the producer or supplier promptly and in writing. In case of dissatisfaction with test results, the producer or supplier may make a claim for rehearing.

## 13. Certification

13.1 When specified in the purchase order or contract, a producer's certification of compliance document shall be reported to the purchaser, verifying that the components manufactured were sampled, tested, and inspected in accordance with this specification and have met the requirements. When specified in the purchase order or contract, a report of test results shall be furnished.

13.2 Certification by an independent third party indicating conformance to the requirements of this specification may be considered upon the request of the purchaser.

13.3 The purchase order or contract shall specify whether or not the certification includes a report of chemical analysis.

## 14. Keywords

14.1 cold pressing; density; powder metallurgy (P/M); prealloyed powder; sintering; stainless steel; structural (P/M) components

## SUPPLEMENTARY REQUIREMENTS

The following supplementary requirements shall apply only when specified by the purchaser in the inquiry, contract, or order. The supplier and the purchaser should agree upon a minimum number of hours survival for the requested corrosion test.

### S1. Intergranular Corrosion Test

S1.1 When specified, material shall pass intergranular corrosion tests conducted by the manufacturer in accordance with Practices A 262.

### S2. Salt Spray (Fog) Testing

S2.1 When specified, material shall pass the salt spray corrosion test conducted by the manufacturer in accordance with Practice B 117.

### S3. Pitting and Crevice Corrosion Test

S3.1 When specified, material shall pass pitting and crevice corrosion tests conducted by the manufacturer in accordance with Test Methods G 48.

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